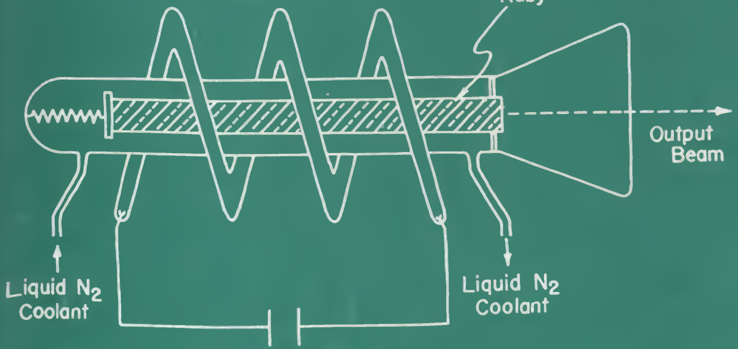
the Mechelec

Volume 22 November - 1963 No. 2

THE RUBY LASER



FLASH
NEW COLUMN --
LETTERS TO . . .
Page 2

THE GEORGE WASHINGTON UNIVERSITY

NOVEMBER 1963

Assignment: match the performance of our finest automatic drive in a lighter, less expensive version!

Result: A new Ford-built 3-speed torque converter—ideal "traveling companion" for our new, hotter, medium-displacement V-8 engines

A completely new Ford Motor Company 3-speed automatic drive for 1964 delivers improved passing performance . . . smoother acceleration . . . better start-ups (up to 35% higher torque multiplication in Low) . . . more flexible downhill braking . . . quieter operation in Neutral.

With the introduction of this lighter, highly durable and efficient transmission in 1964 Comet, Fairlane and Ford models, our engineers have taken still another step toward putting extra pep per pound into Ford-built cars.

Simplified gear case design and a one-piece aluminum casting result in a lighter, more compact transmission—one that has fewer components and is extremely easy to maintain. Built to precision tolerances akin to those in missile production, the new automatic transmission is truly a product of the space age, and is typical of technical progress at Ford.

Another assignment completed; another case of engineering leadership at Ford providing fresh ideas for the American Road.

Ford

MOTOR COMPANY

The American Road, Dearborn, Michigan

WHERE ENGINEERING LEADERSHIP BRINGS YOU BETTER-BUILT CARS

Member
ENGINEERING COLLEGE MAGAZINES ASSOCIATED

Chairman
Professor J. Gale Chumley
Louisiana State Polytechnic Institute
Ruston, La.

National Advertising Representatives
Littell-Murray-Barnhill, Inc.
369 Lexington Ave.
New York 17, N. Y.

the Mecheleciv

VOLUME 22 NOVEMBER - 1963 No. 2

BEHOLD . . .

THINK . . .

WONDER . . .

Published at the George Washington University by direction of the Engineers' Council. Published six times during the school year in October, November, December, March, April, and May. Second class postage paid at Washington, D. C. Address communications to Mecheleciv Magazine, Davis-Hodgkins House, George Washington University, Washington 6, D. C., or telephone FEderal 8-0250, Ext. 528.

Subscription Price: Two Dollars

CHANGE OF ADDRESS: Send your new address at least 30 days before the date of the issue with which it is to take effect.

Letters To . . .

The Editor:

As a student of engineering, I am naturally interested in the philosophy which lead to the elimination of morning classes. If information is available on this subject, please make it available to all engineering students.

H. F.

In answer to this, and other queries, concerning the present engineering schedule, a faculty member having knowledge of the problem was recently interviewed. When the schedule was being proposed, several complaints from students were brought up. Some students complained that their schedules started as early as 9:00 a.m. and ran as late as 8:00 p.m. on the same day. Coupled with this complaint came two others: one was that the day's schedule contained periods of one or two hours duration, periods which were not long enough to complete any work of any length, hence periods of unavoidably wasted time. The other was that a gap of as long as five hours existed between morning and evening classes, a lapse that was long enough to allow the completion of work, provided the student was lucky enough to carry all of the tools he might need, but not long enough to allow the student to return home for these tools should he not be able to carry them with him. The second major complaint came from students who were working on a part time basis. These students stated that many employers would rather have had them work in the morning and go to school in the afternoon, than vice versa. However, with the old schedule, not enough classes of enough variety were offered in the afternoon to allow this "employer satisfaction".

With the present system, a student can now avoid having the schedule arrangement of either of the cases mentioned above. And, another advantage to this schedule is that students can now take electives, which are mainly offered in the morning.

The Engineers' Council:

It is suggested that efforts be undertaken to amend the parking hours in the student parking lots.

The reasons for the recommendation are as follows:

The present hours are 7:00 a.m.-5:30 p.m., and 4:00 p.m. to midnight, each period requiring one ticket (at 30¢ each). If one is a day student he gets, in effect, two day divisions for his thirty cents, e.g., from 7:00 a.m. until noon, and from noon until 5:30 p.m. The night student gets on day division for his thirty cents. If one happens to be a day or full time student enrolled in a school which has no morning classes, but he has both afternoon and evening classes, he attends two day divisions (noon until 5:30 p.m., and 4:00 p.m. until midnight), and must pay sixty cents for the same number of day divisions for which the other day students pay only thirty cents.

Another way of looking at it is that the night ticket covers classes from 5:00 p.m. until 9:00 p.m., but the day ticket covers from 8:00 a.m. until 4:00 p.m.

It is suggested that the night ticket be also valid for two day divisions as is the day ticket. A recommended breakdown is as follows:

0700 a.m. until 5:30 p.m.	one ticket
1:30 p.m. until closing,	one ticket

Any parking overlapping the two periods (example, 12:00 noon to 7:30 p.m.) would require two tickets.

E. J.

The Engineers' Council has already forseen this problem, and is presently attempting to remedy the situation, or, at least, to determine how such a remedy could be achieved. However, the Council appreciates that students are interested enough in the situation to inquire about it, and to offer suggestions such as the one put forth above. It has been suggested that if more students showed their concern over the parking ticket situation, more time would be devoted by responsible persons toward solving the problem as quickly as possible.

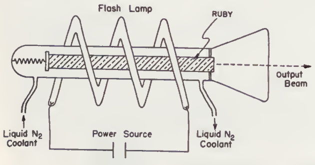
LASERS

EDITORS' NOTE: Rapid progress in laser technology has changed some of the "might be" statements in this article to "has been" statements because the article was written last year. Never-the-less, it is still a good introduction to lasers.

The laser is an out growth of microwave amplification by stimulated emission of radiation (the maser). The successes in this microwave amplification led the maser's developer, C. H. Townes of Columbia University, and A. L. Schawlow in 1958 to propose the feasibility of an optical maser.

The first demonstration of such an optical maser or laser was given two years later in 1960 by scientists of Hughs' Aircraft Company. This first light amplification by stimulated emission of radiation was followed by similar demonstrations by IBM laboratories and Bell Telephone laboratories. The system used at IBM, as contrasted to the ruby system used by Hughs and Bell Telephone, produced a light beam from a supercooled crystal of calcium fluoride impregnated with uranium atoms. This system, however, could not handle large amounts of power due to its low operating temperature.

The ruby laser has thus far proven itself to be the most successful solid state light amplifier produced. The ruby is, in each case, a synthetically produced aluminum oxide containing 0.05% of 0.5% chromium ion. The ruby is machined into a cylindrical rod approximately 4.0 cm in length and 0.25 cm in radius. The ends are optically polished parallel and silvered on the ends. One end, the fore end, is only half silvered to permit the escape of the emitted radiation. The rod is enclosed in a cooling envelope and surrounded by an electronic flash tube which provides the energy used in initiating stimulated emission (see diagram).



The pale pink color of the ruby is due to selective absorption of a broad band of green, yellow, and ultraviolet wavelengths by the chromium atoms. The energy absorbed raises the chromium atoms to one of two higher energy levels. (Actually, electrons are raised to higher energy levels, but hereafter this will be referred to as raising atoms to higher energy levels.) Upon falling back to lower energy levels, the chromium atoms give up some of their energy and land temporarily in a metastable state. If the atoms are not subjected to further stimulation, they remain in this metastable state a few milliseconds and then drop to the ground state at random, emitting light energy having a wavelength of 6,943 A.

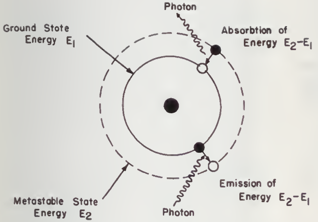
Stimulated emission occurs when immense numbers of these atoms are "pumped" to the metastable state and then further induced to emit radiation in a brief pulse. In practice the flash lamp provides the "pumping" energy needed for the stimulated emission.

The frequency of transition from the metastable state to the ground state is given by

$$f = (E_2 - E_1)h = 6{,}943 \text{ A}$$

where E_2 and E_1 are the respective energies of the metastable and ground states and h is Planck's constant. An atom in the metastable state will emit a photon of the characteristic wavelength when stimulated by a photon from another chromium atom. A multiplicity of such events quickly builds to a saturation point in the ruby, and a laser pulse is produced. In order to have these stimulated emissions take place, there must be what is called an inverted Boltzman distribution of electrons (i.e. there must be more electrons in the metastable state than there are in the ground state). When the critical point of saturation is reached, the photons escape from the ruby and are emitted as an extremely intense wavefront of coherent radiation. The photons emitted by stimulated emission are forced into a coherent, in-step beam by repeated reflection back and forth parallel to the longitudinal transverse axis

by Dillon F. Scofield



by the silvered and partially silvered ends of the ruby rod. Photons divergent from the optical axis escape and are either absorbed by the apparatus or are observed as a rosy glow of the laser tube.

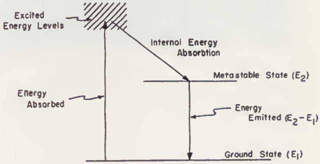
Operating characteristics of the pulsed laser are described mathematically only by means of the theory of quantum mechanics and so only qualitative results will be given here. The solution of the differential equations of quantum mechanics describes the wave shape of the emitted pulse of radiation. The pulse is found to be modulated and has an amplitude related to the coherence and emission intensity. Another result is that the pulse dies exponentially.

The wavelength is generally longer than the inter-molecular distance. It can be assumed that the radiation field acts upon the entire molecular system of the laser proper. Efficiency of a typical laser is about 10,000 watts in short bursts. At threshold level the band spread is only 0.02A or about 1,000 megacycles — at least as narrow as any conventionally available non-laser spectral source.

As most substances radiate at wavelengths other than the visible or near infrared, the laser is singularly unaffected by most thermal noise. The noise that is produced in the laser is due to the energy difference between input photons and output photons. Maser amplifiers operate at noise levels as low as 20^oK. Power consumption in the ruby laser is usually great because of the large amount of energy needed to raise many atoms out of the ground state to the metastable state so that emission may occur. To overcome this problem, newer cooling techniques and materials are being explored at the present time. They include samarium or uranium dopped calcium fluoride crystals oscillating at 7,080 A and 25,000 A, respectively.

The newest and most promising technique dispenses entirely with the solid state. This new device, the Ne-He gaseous laser, even in the present state of development is considered to be much more sophisticated. The gaseous laser, developed by Ali Javan and a group consisting of W. R. Bennett, Jr., and D. R. Herriott, was demonstrated in 1962. Operating on only 50 watts, the gaseous laser's output per kilocycle band width is about 100 million times that of a cm^2 surface of our sun. The new laser produces spectral lines less than one kilocycle wide at a carrier frequency of 100,000 megacycles.

A Young interference experiment further exemplifies differences between the solid state and gaseous laser. As usually conducted, a small source of light is placed far behind a plate cut with parallel slits. Light passing through these slits produces an interference pattern on a screen placed on the side opposite the light source. The sharpness of the interference pattern can, in effect, become a test of the parallelness of the light passing through the slits. With the laser, an



(Continued on page 11)

MECH MISS

The ASME STUDENT CHAPTER
PROUDLY ANNOUNCES . . . .

Quietly, Miss Priscilla Bloom steps up to the judges and puts forth her greatest efforts to impressing them with her outstanding service record, and, of course, her delicate beauty. Before this publication is on the stands, we will know whether the judges for the homecoming queen finalists are able to recognize that Priscilla is a "Prize". To give you an example of what Priscilla has going for her, she is a "just right" 5'5" tall, with dark brown hair, and unusual hyacinth eyes.

As a junior majoring in speech therapy, she varies her interests but engaging in bridge, choreography and dancing, swimming, tennis, and reading. Besides going to school, she works as a secretary in the Engineering School Business Office, and as a part time adviser to the USY chapter of Arlington.

Her day is completed by service work to Phi Sigma Sigma Sorority (of which she was her pledge class president) as social chairman, to the Student Council as the Lower Columbian College Representative, and to the Student Planning Commission as Secretary – and, no less, to the Urban Service Corps or her community.

If all this doesn't pull at least a "Finalists" standing for our Priscilla, then we had better have the judges impeached for incompetency.

THE SCIENCES

Pure and Applied

by Erling R. Jacobsen, TβΠ

Since the dawn of the atomic age, the conceptual nature of science has been closely scrutinized. This has revealed fundamental philosophical differences underlying the pure and the applied sciences. An awareness of these differences naturally leads to a consideration of the peculiar problems associated with these two distinct kinds of scientist. It is my purpose to mull over with you, today's technical students and professors, some of the problems that these differences produce.

The public, and I include in this public some very well qualified educators, has the impression that the pure scientist is a person who is solely engaged in research, and that the applied scientist uses the pure scientist's discoveries to build things. I feel such impressions are wholly incorrect and lead to unfortunate conclusions. The pure scientist, identified with the research specialists, enjoys a social and intellectual prestige by virtue of association with the tremendous technological advances of the past three or four decades. Of much more importance than prestige, however, is a problem of considerable sociological seriousness. The pure scientist is identified with the research elements of the applied fields. Furthermore, because of the esoteric nature of his accomplishments, he is often accorded a superior intellectual position in the public mind and is frequently sought out to dictate the total direction of applied science, particularly in the academic area.

I intend to redefine terms and show that an ideological chasm exists between pure and applied science. I will also consider that although the pure scientists, as redefined, are few in number, they may have a disproportionate influence in certain fields of scientific education at the present time. In this context, mathematics is examined; and it may appear that this paper is a criticism of pure mathematics or mathematics in general. This is not my intention. The "new" mathematics has only been used as an example because it appears to have some of the characteristics of a pure science. As such, its acceptance by the public to the extent that its philosophies permeate society should be subjected to close scrutiny.

* * * * * * *

Before we delve more deeply into this subject, I believe that it is desirable to bring engineers into the picture. Many engineers distrust the term "applied science" primarily because its definition has been obscure and is frequently applied to those technical research endeavors about which the engineers themselves are not thoroughly informed. Actually, applied science is a generic term and includes engineering as its only separately identified element.

During the industrial revolution, engineers were primarily concerned with design and construction, and the group known as scientists were engaged in laboratories. Initially, the latter investigated physical phenomena because more complete knowledge of them enabled more efficient design of useful items. They were also concerned with the research and development activities which were necessary to accomplish specific useful objectives. As such, most of these scientists and engineers would be applied scientists in the same sense as this term is used in this paper.

Toward the end of the 19th century, the group known as engineers, reflecting public demand for the immediate benefits of the revolution, became more concerned with the design and production of "more-of-the-same" items than with research. At this time, research was necessarily of lesser priority. A change was taking place at this same time among the scientists. The accumulation of scientific knowledge encouraged some to explore phenomena purely for the knowledge thus obtained and with no immediate useful objective in mind. Even though scientists working in the applied sense still represented the great majority and continued to make tremendous technological strides, the abstract and often exciting revelation of the pure scientist caught the public eye and seemingly widened the gap between engineering and "science". This was particularly true when, either by chance or by the conscious efforts of an applied scientist, useful applications of an abstract development were discovered.

Since the beginning of the 20th century, particularly as specialties in the new fields of engineering (electrical, chemical, aeronautical, marine, etc.) were developed, engineering research expanded. This has continued to the present day. It is now difficult to discern major differences between, say, an electrical engineer and an applied physicist in electronics, and most firms would hire either to fill the same job slot. I imagine that those who are more closely associated with laboratory research might tend towards calling themselves some kind of applied scientist, whereas those who are primarily in design or production might prefer the title "engineer"; but they all have the one common goal -- attempting to fulfill a technological need expressed by society. Both are applied scientists and differ from the pure scientist in that the latter is still unconcerned with application.

In a recent editorial,[1] John D. Ryder felt that the old definition of an engineer was limiting. This definition was that "an engineer is a person educated in the principles of mathematics and the physical sciences who applies this knowledge to direct and control the materials and forces of nature for the safe, economic use and convenience of man." Mr. Ryder noted that economics and convenience do not always enter into an engineering decision; and after some further discussion, he concluded that it might be best not to make a firm definition.

I believe that, with slight modifications, the old definition still applies and will also tend to end disagreement over the terms "engineer" and "applied scientist." The modified phrase would be: "An applied scientist or engineer is a person educated in the principles of mathematics and the sciences who applied this knowledge to direct and control the materials and forces of nature in consideration of their safe, economic use and convenience of man." The

AN OPEN LETTER TO MECHANICAL ENGINEERING STUDENTS

Fellow Struggling M.E.:

Keep struggling... My name is Millard Carr, this year I'm Chairman of the Student Section of the American Society af Mechanical Engineering here at G.W. I know you get a lot of junk mail from people trying to sell you something but, I hope, you will take a minute of your time to read this letter. I honestly think it will be of some value to you. If not you can roll it up, fill it with tobacco and smoke it.

I'd like to explain to you what we in A.S.M.E. do and of just what value the Society may be to you. First of all, A.S.M.E. provides a central rallying point outside of class for all of us battle weary M.E.'s. Here we can gather together once a month, soak up coffee and donuts, and complain about the nasty old M.E. professors, the curriculum, labs, grading system, E.E.'s, lack of girls, etc. There are always many sympathetic ears at the meetings, not to mention several glassy eyed upper classmen who may be able to help with homework, or at least provide back exams.

In a more serious vein, at each meeting we try to have an interesting speaker from the engineering profession around the Washington area. These speakers present a talk, usually with a film, on some current M.E. development or facet. In this way, we hope to bridge the gap between the theory we get in class and the real life application of a practicing mechanical engineer. We try to keep the talks aimed high enough to be of real interest and low enough so that, if you stay awake, you're bound to follow the story.

Throughout the year, several special meetings are planned, such as the tour of N.A.S.A. in October and the upcoming tour of the David Taylor Model Basin. This may sound like propaganda for English I, but one of the most useful skills an engineer can develop is the ability to deal with people and to communicate his ideas to other engineers. A.S.M.E. provides the place to develop this skill in a friendly atmosphere. Besides the normal operations of the Chapter, every Spring a paper contest is held at which members compete for cash prizes by presenting papers on any engineering subject. This is a good opportunity to practice giving a technical paper...and also an easy way to pick up a piece of that root of all evil.

Participation in the Student Section is good preparation for joining the A.S.M.E. on the graduate level. It's an easy transition from the Student Section to the National Society. Also, many contacts are made through A.S.M.E. which will be valuable assets in the professional world.

Mechanical Engineering is not an occupation, it's a profession. This means that it demands a certain amount of plain old-fashioned hard work. You already know, or will know shortly, how much scholastic effort is required to get an M.E. degree; a little more effort is required to develop professionally. Participation in a professional organization such as A.S.M.E. can only increase your value as an engineer in the future.

Our meetings are held at 8:15 p.m. on the first Wednesday of every month. The M.E. bulletin board on the north steps af Thompkins Hall will give all the information as to room, speaker or program....and refreshments. I hope you'll get off the back of your lap, come out to our next meeting and look us over; who knows, you may even decide to join in.

Sincerely,

Millard Carr

major difference between the applied scientist (or engineer) and the pure scientist is that the former considers all of the factors which are concerned with the eventual application of his work. How he weighs any given factor in his eventual decision varies from project to project, but the fact remains that he, or his associates, at some time gives consideration to the concept of use.

* * * * * * *

As I have discussed the relationship between the engineer and applied scientist, I have made some effort to point out the difference between pure and applied science as I see it. In a letter[2], Forest M. Kovacs discusses some of the sociological consequences in a society which is strongly influenced by "purists". Referring to C. P. Snow's, Two Cultures and the Scientific Revolution, Mr. Kovacs noted that Sir Charles called the pure scientists who did not comprehend the industrial revolution "natural Luddites" because they prided themselves in doing work that was not practical: "In fact, the more firmly one could make that claim, the more superior he felt!" Mr. Kovacs continues, "Whenever . . . the pure scientists provide a direction for society, those activities which are non-productive will be encouraged!" The effect, of course, if a total society accepted this direction, would be, at the very least, stagnation. Although Mr. Kovacs discussed the problem from a somewhat different standpoint, I believe that his letter hits upon a very important point. I would like to pose the question, "To what extent are the purists directing, or attempting to direct, society at the present time?"

(Continued on page 11)

LASERS — Continued from page 5

interference pattern is achieved even when the laser is right up against the plate. In the ruby laser, the width of coherence is limited to within 1/10 of the rods diameter, because of crystal imperfections. However, the gas laser extends coherence across the entire width of the end plates.

The gaseous laser resembles, to some extent, an externally excited neon display tube. The tube in this case is filled with a helium and neon mixture. The construction is similar in purpose to the ruby laser. Here, however, the stimulated emission is induced in the gaseous neon. The principle of high coherence and intensity obtained by multiple reflection from silvered end plates is retained but as the tube operates continuously, one end mirror seems not to exist. The energy to excite the neon atoms is provided indirectly. A radio frequency electric field accelerates the helium atoms in the tube. These in turn impart some of their energy to the neon atoms upon collision. The activated neon atoms can radiate at almost any of four upper quantum levels, or some ten quantum sub-levels, emitting some 30 discrete frequencies, depending upon the laser operation, when stimulated by an external photon. The photon emitted in the first step does not contribute to the laser beam and the activated neon atom continues, upon stimulation, to radiate from some 10 lower energy levels. The present operation range is 11,000 - 12,000 A^{o} and ultimately 9,000 - 17,000 A^{o}. The output line is 60 times sharper than the ruby laser line. The band spread is 10^{-5} times as large as conventional sources. This low spread has made possible the first experimental observation of difference signals at radio frequency between two optical lines.

Applications of both lasers are numerous. They include: research into the nature of the chemical bond when subjected to intense localized and modulated radiation; applications to medicine such as the burning of corneal tumors and the cauterization of wounds; research into atomic interactions in intense fields of radiation; and military uses such as a "ray gun" capable of melting through dense steel plating in microseconds, and a "radar" for space navigation. Already, the present crude gaseous laser is capable of a resolution of one mile in 100,000 when used in a "radar" system. Even at an assumed efficiency of 10%, a laser space radar could operate on 800 watts in wide angle searching. Providing that accurate modulation is possible, there are several plans proposed by which velocity determinations of space vehicles by means of Doppler shift would be practical. Of all practical applications of the laser, none possesses as much promise as does communications. Theoretical and experimental studies have found that amplitude modulation of the output can be carried out with most lasers.

Amplification of laser signals is practicable simply by keeping the pumping rate continuously operating laser, just below that needed for continuous sustained emission. Incident laser beam energy from another source would then provide the energy to initiate intense photo amplification. A photo-electric hookup could convert the amplified beam into the usual sort of electronic signals. Such a laser "receiving set" would be capable of very highly directional selective reception, even against a backdrop of our sun. The transmitter, using suitable modulation techniques could carry, on a band width of 100,000 megacycles, as much data as all the radio communication channels now existing. This signal could be carried underground by trunk cables of optical fibers. Broad band modulation of the laser signal has already been accomplished at frequencies up to 60 KC, and in December 1960, BTL scientists used a Kerr Cell to impress a telephone message on a laser transmitter receiver system. More recently they displayed a system which transmitted video telephone conversations by a laser beam. This year scientists of the University of Michigan detected the second harmonic of a wavelength of 6,943A^{o} and were able to heterodyne two waves producing a third wave. Through such harmonic mixers, it may be ultimately possible to produce superheterodyne transmitters and receivers capable of transmitting and receiving all optical wavelengths. Through the laser, man may be able to transmit information to the earth gathered from the moon and beyond.

THE SCIENCES — Continued from page 9

Before attempting an answer to this question, and perhaps somewhat in anticipation of the answer, I would like to state that I do not believe that the scientific purists are consciously trying to direct society, but rather that society is seeking their guidance. People seek counsel and guidance from those whom they believe are the most qualified to give it. They are also impressed by that which they cannot understand but which has been lauded publicly. In terms of percentage, the largest numbers of pure scientists will be found in the universities, and this enhances their prestige. It is because education plays such an important part in our society that such persons can have a tremendous effect if their direction is sought and followed. It seems that, at the present time, all of the ingredients for such influence to be sought are present. At no time in history has there been such a respect for "science" and a critical interest in "modernizing" educational methods as there is now. I think that there are several indications that there is an inordinate amount of influence by the pure scientists in our educational scheme, and that, if caution is not observed in its acceptance, the results may become a matter of national concern.

* * * * * * *

The scientific field in which this sort of influence is most apparent is mathematics. Persons advocating change in high school and elementary teaching methods point to the "new" mathematics as indicative of the way that all teaching should be reformed. The public acclaim for "new" mathematics should awaken a feeling of caution among applied scientists and engineers. Most of the students studying mathematics do so to have a tool, and their education should provide them with that tool. Methods of teaching mathematics

(Continued on page 14)

TECH NEWS

BIONICS

Born less than two years ago, the new science of bionics has been said to have potential applications more revolutionary than that of the first computers. The word bionics is a contraction of biology and electronics, but the area taken in by the new field cuts across the traditional boundaries of a dozen major sciences and hundreds of lesser ones.

Bionics has been defined as an effort to utilize knowledge gained from the study of living organisms in the solution of engineering problems -- in effect, an attempt to cross-fertilize biology, medicine, physics, engineering, electronics, mathematics and many other heretofore well-separated disciplines.

One example of what bionics has achieved so far is the infrared guidance system of the Sidewinder air-to-air rocket. The guidance package is the outcome of research on rattlesnakes, which have extremely precise heat sensors so accurate that the snakes can distinguish a friend from a foe by the heat radiating from its body.

Another area in which bionics holds great promise is development of a new kind of filter to trap the minutest amounts of moisture in rocket fuels -- an old and often costly problem faced by missile scientists. The human kidney is the finest filter known, and it is believed that a man-made filter only a fraction as effective would do the job.

Bionic scientists are looking toward electronic devices which can repair themselves if they breakdown, and which will be able to "learn" from experience how to select different alternatives. Self-adaptive machines are being sought which will automatically adjust themselves to changing tasks and situations. Bionic devices are coming ever closer to achieving that which up to now has been characteristic only of human intelligent behavior.

The emergence of bionics as a separate science points up the fact that our various technologies are becoming more and more inter-disciplinary. Dividing lines between scientific fields are becoming finer, and the new regrouping of basic and applied sciences which bionics represents may well work a new economic, medical and industrial revolution.

For electronic instrumentation, bionics opens a vastly enlarged field. As man-made systems become more sophisticated, the electronic apparatus that will control so many of them will become infinitely more complex. It is through this series, "Instruments of the Future," that Horman Associates, Inc., hopes to demonstrate its awareness of the coming challenge.

As in the past, we will continue to provide up-to-date information on new instrumentation as well as expert advice in its selection and application, and fast, reliable service and calibration facilities. Look ahead with Horman--your best guide to an age that may be known to future generations as "The Electronic Sixties."

NEW SOLID-STATE LASER

A new type of laser in which coherent light is generated directly by passing an electric current through a semiconductor crystal has been created by General Electric. This marks a major milestone in laser research.

The ability of gallium-arsenide junctions to produce infrared light has been previously observed in several laboratories. The General Electric device, however, is the first to generate coherent light.

The most familiar laser, of the type first announced slightly more than two years ago, employs a ruby or similar crystal which is "pumped" optically by a high-intensity external light source. Then later lasers were excited by passing an electrical discharge through a mixture of gases. The new laser is excited directly by injecting electrons into a junction-plane less than a ten-thousandth of an inch thick in the middle of a tiny diode of gallium arsenide. To achieve laser action, intense electric currents as high as 20,000 amperes per square centimeter are applied. The current is applied in pulses and the crystal refrigerated in liquid nitrogen or liquid helium. This keeps the crystal from overheating.

Warren, Mich. -- A new technique for creating crosswind forces on a moving automobile with a rocket engine has been developed by General Motors Research Laboratories under direction of Joseph B. Bidwell, head of Engineering Mechanics Department.

The technique, according to a report by R. Thomas Bundorf and Donald E. Pollock of GM Research and M. C. Hardin of Allison Division, utilizes an experimental rocket engine mounted on the side of a passenger car or station wagon body.

The result has been verification of equations of lateral motions used in computer simulation of car handling. By recording vehicle motions when the rocket engine is fired, GM Research engineers proved that the computer method accurately simulates crosswind effects.

Another feature of the technique is that it provides a relatively quick means of investigating the crosswind stability of an actual automobile. Force of the thrust is accurately controlled, as is the "force-time" curve of each test run with the vehicle.

Early efforts to simulate crosswinds or "wind disturbance inputs" involved a propeller-driven wind blast from the roadside against the side of a moving vehicle. Usually it was done with aircraft propellers. Main disadvantage of this technique was that the moving vehicle was in the crosswind only a short time.

Attempts to test automobiles in actual crosswinds proved impracticable because winds were both unpredictable and variable and couldn't be measured accurately.

STATEMENT OF OWNERSHIP, MANAGEMENT AND CIRCULATION
(Act of October 23, 1962: Section 4369, Title 39, United States Code)

Publisher: File two copies of this form with your postmaster

1. DATE OF FILING: 24 Sept 63

2. TITLE OF PUBLICATION: MECHELECIV MAGAZINE

3. FREQUENCY OF ISSUE: once per month; during months of March, April, May, October, November, and December

4. LOCATION OF KNOWN OFFICE OF PUBLICATION (Street, city, county, state, zip code): 731 22nd St., N.W., D.C., 20006

5. LOCATION OF THE HEADQUARTERS OF GENERAL BUSINESS OFFICES OF THE PUBLISHERS (Not printers): 731 22nd St., N.W., D.C. 20006

6. NAMES AND ADDRESSES OF PUBLISHER, EDITOR, AND MANAGING EDITOR

PUBLISHER (Name and address): Prince Lithograph, 4019 5th Rd., North, Arlington, Virginia

EDITOR (Name and address): Jud th J. Popowsky, 1329 Delafield Pl., N.W., D.C., 20011

Assistant Editor: ROBERT HAHN, 730 19th St., N.W., D.C., 20006

7. OWNER (If owned by a corporation, its name and address must be stated and also immediately thereunder the names and addresses of stockholders owning or holding 1 percent or more of total amount of stock. If not owned by a corporation, the names and addresses of the individual owners must be given. If owned by a partnership or other unincorporated firm, its name and address, as well as that of each individual must be given.)

NAME	ADDRESS
NONE	

8. KNOWN BONDHOLDERS, MORTGAGEES, AND OTHER SECURITY HOLDERS OWNING OR HOLDING 1 PERCENT OR MORE OF TOTAL AMOUNT OF BONDS, MORTGAGES OR OTHER SECURITIES (If there are none, so state)

NAME	ADDRESS
NONE	

9. Paragraphs 7 and 8 include, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting, also the statements in the two paragraphs show the affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner. Names and addresses of individuals who are stockholders of a corporation which itself is a stockholder or holder of bonds, mortgages or other securities of the publishing corporation have been included in paragraphs 7 and 8 when the interests of such individuals are equivalent to 1 percent or more of the total amount of the stock or securities of the publishing corporation.

10. THIS ITEM MUST BE COMPLETED FOR ALL PUBLICATIONS EXCEPT THOSE WHICH DO NOT CARRY ADVERTISING OTHER THAN THE PUBLISHER'S OWN AND WHICH ARE NAMED IN SECTIONS 132.231, 132.232, AND 132.233, POSTAL MANUAL (Sections 4355a, 4355b, and 4356 of Title 39, United States Code)

	AVERAGE NO. COPIES EACH ISSUE DURING PRECEDING 12 MONTHS	SINGLE ISSUE NEAREST TO FILING DATE
A. TOTAL NO. COPIES PRINTED (Net Press Run)	1700	1700
B. PAID CIRCULATION 1. TO TERM SUBSCRIBERS BY MAIL, CARRIER DELIVERY OR BY OTHER MEANS	50	50
2. SALES THROUGH AGENTS, NEWS DEALERS, OR OTHERWISE	0	0
C. FREE DISTRIBUTION (including samples) BY MAIL, CARRIER DELIVERY, OR BY OTHER MEANS	1350	1350
D. TOTAL NO. OF COPIES DISTRIBUTED (Sum of lines B1, B2 and C)	1400	1400

I certify that the statements made by me above are correct and complete ▶ (Signature of editor, publisher, business manager, or owner) Judith J Popowsky

POD Form 3526 Aug. 1963

INDEX TO ADVERTISERS

could stand improvement; there is some question, however, whether the present trend will result in the needed improvement.

If one is willing to accept the fact that most students will have a need for an understanding of applied mathematics (whether it be for the calculation of an income tax or the re-entry orbit of a satellite), a question should be raised as to whether the "new" mathematics is dedicated to this end. I had the opportunity, recently, to listen to a mathematician who had been hired by a county school board to re-train high school and grade school teachers in methods to be used for teaching "new" mathematics. The occasion was a parent-teacher meeting, and many parents had questions from the floor. One parent noted that his son in fifth grade was unable to make change in a supermarket purchase; another complained that his sixth grade youngster was unable to perform simple multiplication and had, at no time, learned the multiplication tables. The mathematics specialist answered that absolutely no emphasis was placed on multiplication rules per se or on rote memorization of tables. The student should be able to understand the mathematical principles of multiplication and should be able to deduce the current system. If the student had not, there was little left for him to do but to memorize the tables - on his own time, of course. Throughout the entire lecture, the theme was that there would be a de-emphasis on memorizing the "old" rules of mathematics and an emphasis on "understanding" the "new" mathematical "principles."

The average person does not have much opportunity to question the mathematician on the application of the "new" mathematics. The applied scientist should, however, read literature on this subject. He can then determine whether the new methods ensure that more people will be able to apply mathematics with increased capability, or whether these methods will, in fact, tend to decrease the capability. As a start, read the pamphlet entitled The New Mathematics, distributed by the National Education Association.[3] Irving Adler's paper-backed edition by the same title[4] contains a fundamental description of the subject. It is written in a very readable style to ". . . help the layman to discover the meaning of the revolutionary development in the world of modern mathematics." The meaning will be clear to the reader in terms of the distinction made in this paper.

The difference between an improved method of teaching and the new method espoused by the pure mathematicians is well shown by a comparison between two texts on the subject. The first is a text on vector analysis by Harry F. Davis[5]; the second, by Sam Perlis[6], deals with matrix theory. (Both are mathematics professors.) Mr. Perlis makes an extended and successful effort to avoid any practical application; in contrast, Mr. Davis devotes the first half of his book to the thorough understanding of how vectors are applied in all fields of science. The latter half of his text is theoretical, explaining the operations used in the first part of the book, and preparing the student for more advanced courses in applied mathematics.

* * * * * * *

In the above discussion, I have tried to show that the field of "new" mathematics may be one area in which the pure scientist is providing the direction for society. If this is the case, and the future scientists and engineers are to be indoctrinated in mathematical methods which tend to ignore practical application, then the transition to an applied field at university level will be all but impossible. Because of this, I feel that there is sufficient reason to study the matter much more closely.

Of course, part of any study is a matter of interpretation, and the field of mathematics is open to many interpretations. In NEA's pamphlet, The New Mathematics, it is noted that the new mathematics is needed because" . . . a higher degree and different type of proficiency in mathematics is essential in most of today's careers," and that "Automation . . . has been possible only through the development of new mathematics and new uses of mathematics." Through this and other publications, the "new" mathematics movement encourages the belief that advances in the applied sciences owe their very existence to the movement. It is implied that the "new" mathematics was created for, and, moreover, fulfills the needs of the applied sciences.

The development of the "new" mathematics may be interpreted, however, in a different manner. As the field of applied science and engineering advanced more and more and became highly specialized, more persons required extended capabilities in applying advanced mathematics to their work. Students, particularly in the fields of engineering and physics, found that the teaching methods used by mathematics departments in advanced courses did not prepare them to cope with practical problems. As a result many engineering schools have to devote a great deal of time in their courses to retrain their students in applied advanced mathematics. They often require that mathematics courses be taught by the engineering staff, duplicating those courses already taught by the mathematics departments. Consequently, the mathematics departments were often asked to change their teaching methods so that this duplication and the subsequent loss of time would be minimized. Mathematics professors have told me that this sort of criticism was unjustified, that the students were inadequately prepared at high school level to comprehend fully the pure mathematical approach at the university. The logical solution, in their minds, was to introduce pure mathematics at the high school, or even elementary school, level.

With this line of reasoning, it would appear that the development of "new" mathematics at pre-university levels was undertaken to make pure mathematics at university level more understandable. This also indicates that here is further evidence that pure mathematics is indeed providing a direction for society. A rather important question, however, remains. Does the comprehension of pure mathematics at any level further its use in applied sciences? To answer this question, let's turn to the most skilled pure mathematician available, the university mathematics professor. Such people find it difficult, if not impossible, to apply their knowledge to the

solution of a practical problem. The ability to solve practical problems is considerably weakened by an attitude that practical application is not a necessary ingredient of mathematics. This being the case, is it not asking quite a bit of a student to bridge the gap between pure and applied mathematics on his own?

This interpretation of the development of the "new" mathematics de-emphasizes the role of pure mathematics in the advances of the applied sciences. In contrast to the implications outlined in the NEA pamphlet, I suggest that the applied scientist, in the investigation or development of a new device or principle, may well have found it to behave in a manner described in mathematical terms. As he delved into the mathematics, he discovered that this aspect had been explored already in considerable detail, albeit in an abstract fashion, by a pure mathematician who had made no effort to seek a use for his study. The applied scientist could, with appropriate modification, translate the abstract mathematics into a useful reality.

* * *

For a society to move forward, the emphasis must necessarily be on production and application, and most people should be educated along these lines. It should be emphasized that this paper is not intended to minimize the contribution of pure science -- this is considerable. My main contention is that the influence on society, of the very distinct philosophies of pure and applied science must be distinguished between and given careful consideration.

BIBLIOGRAPHY

1. "To Define Is To Limit", by John D. Ryder, editorial appearing in The Proceedings of the IEEE, September 1963, Vol. 41, No. 9, p. 1175.
2. "In Praise of the Engineering Education" by Forest M. Kovacs, correspondence appearing in The Proceedings of the IEEE, September 1963, Vol. 51, No. 9, p. 1254.
3. The New Mathematics, published by the Publications Division of the National Education Association, 1201 16th St., Washington 6, D. C.
4. The New Mathematics, Irving Adler, The New American Library, New York, New York, 1960.
5. Introduction to Vector Analysis, Harry F. Davis, Allyn and Bacon, Boston, Massachusetts, 1961.
6. Theory of Matrices, Sam Perlis, Addison-Wesley, Reading, Massachusetts, 1958.

Solid opportunities with solid state devices

Last summer at one of the ROTC summer camps one of the cadets was sent down to a stream to get some drinking water for the platoon, but had not been gone long when he came running back to the camp empty handed and panting. "Sir," he exclaimed, "there's a big alligator in the stream and I'm afraid to get the water."

"Don't worry son," said the sympathetic officer. "That alligator is probably 4 times as scared of you as you are from him."

"Well sir," replied the cadet, "if that alligator's only half as scared as I am, that water ain't fit to drink."

* * *

The wife was always antagonized by her husband's going out at night. His departing words, which especially angered her, were always. "Good night, mother of three."

But one night, she could stand it no longer, and when he took his hat, started out the door, and called cheerily, "Good night, mother of three" she answered quite as cheerily, "Good night, father of one."

Now he stays home.

* * *

The doctor finished his examination of a sweet young thing. "A very difficult case to diagnose," said the doctor. "But as near as I can tell you're either going to have a baby or else you have a cold."

"It must be a baby," the chick said emphatically, "because I don't know anyone who could have given me a cold."

What can a bird do that seven out of ten people cannot? Make a small deposit on a new car.

* * *

Golf is a game in which a ball 1-1/2 inches in diameter is placed on another ball 8,000 miles in diameter. The object of the game is to hit the small ball and not the big one.

* * *

Little Audrey, mad as hell
Pushed her sister in the well.
Said her mother drawing water,
"Gee, it's hard to raise a daughter."

* * *

Famous last words: "Oh hell, they don't flunk Seniors."

* * *

A young girl went into a doctor's office and he gave her a thorough examination.

Doctor: "What is your husband's name?

Girl: I have no husband.

Doctor: What is your boyfriend's name?

Girl: I have no boyfriend.

The doctor went to the office window and raised the shade. The girl asked what he was doing and he replied:

"The last time this happened a star rose in the East and I don't want to miss it."

* * *

Judge: "Officer, what makes you think this man is drunk?"

Officer: "Well, Judge, I didn't bother him when he staggered down the street or when he fell flat on his face, but when he put a nickel in the mailbox, looked up at the clock on the Baptist Church and said, 'My God, I've lost 14 pounds,' I brought him in."

* * *

"Halt, who goes there?"

"American."

"Advance and recite the second verse of 'The Star Spangled Banner.'"

"I don't know it."

"Proceed, American."

Mother: "Now, Junior, be a good boy and say 'Ah-h-h-' so the doctor can get his finger out of your mouth.

* * *

He drove quite a distance into the country, stopped the car and asked the girl, "Are you a Chesterfield or a Camel girl?"

Somewhat confused, she asked, "What do you mean?"

He said, "Would you rather satisfy or walk a mile?"

* * *

Angry father: "What do you mean by bringing my daughter home at this hour of the morning?"

Engineer: "Have to be in class by eight."

* * *

"What happened to your Tire?"

"Ran over a milk bottle."

"Didn't you see it in time?"

"Naw, the kid had it under his coat."

* * *

Knees are a luxury these days. If you don't think so, just try to get your hands on one.

* * *

It seems that in Cuba the stamps with Castro's picture on them aren't selling too well, the reason being they won't stick. The people keep spitting on the wrong side.

* * *

Mrs. Worthmore and French poodle were shopping one day, when she noticed an E.E. standing next to her who was looking fearfully at the puppy frisking about his legs. "My, my," she said, "don't be afraid of Felix; he won't bite you." "Madame," said the man, "I wasn't afraid he'd bite, but I noticed him lifting his hind leg and I thought he was going to kick me."

COULD YOU OUT-THINK A COMPETITOR?

Consider a Career in Technical Marketing

An Interview with G.E.'s J. S. Smith, Vice President, Marketing and Public Relations

Mr. Smith is a member of General Electric's Executive Office and is in charge of Marketing and Public Relations Services. Activities reporting to Mr. Smith include marketing consultation, sales and distribution, marketing research, marketing personnel development, and public relations as well as General Electric's participation in the forthcoming New York World's Fair. In his career with the Company, he has had a wide variety of assignments in finance, relations, and marketing, and was General Manager of the Company's Outdoor Lighting Department prior to his present appointment in 1961.

For more information on a career in Technical Marketing, write General Electric Company, Section 699-08, Schenectady, New York 12305.

Q. Mr. Smith, I know engineering plays a role in the design and manufacture of General Electric products, but what place is there for an engineer in marketing?

A. For certain exceptionally talented individuals, a career in technical marketing offers extraordinary opportunity. You learn fast what the real needs of customers are, under actual industrial conditions. You are brought face-to-face with the economic realities of business. You participate in some of the most exciting strategic work in the world: planning how to out-engineer and out-sell competitors for a major installation.

Q. Sounds exciting. But I've worked hard for my technical degree. I'm worried that if I go into marketing, I won't use it.

A. Don't worry—you'll use all the engineering you've learned, and you'll go on learning for the rest of your life. In fact, you'll have to. You see, the basic purpose of business is to sense changing customer needs, and then marshal resources to meet them profitably. That means that you must learn to know each customer's operations and needs almost as well as he understands them himself. And with competitors trying their best to outdo you, believe me—every bit of knowledge and skill you've got will be called into play.

Q. Is that why you said you wanted "exceptionally talented people"?

A. Technical marketing is not everybody's dish of tea. It takes great personal drive and energy, and a talent for managing the work of others in concert with your own. It takes flexibility . . . imagination . . . ingenuity . . . quick reflexes . . . leadership qualities. If you're nervous with people or upset by quick-changing situations, I don't think technical marketing's for you. But if you are excited by competition, like to help others solve technical problems, and enjoy seeing your technical work put to the test of real operation—then you may be one of the ambitious men we're looking for.

Q. Now what, actually, does a man do in technical marketing?

A. Let me describe a typical situation in General Electric. A field sales engineer is in regular contact with his customers. Let's say one of them makes an inquiry, or the sales engineer senses that the time is right for a proposition. With his field application engineer, he determines the basic equipment needed. Then he contacts the marketing sales specialist in the G-E department that manufactures that equipment. The sales specialist, working closely with his department's product engineers, specifies an exact design—realistic in function and cost. Then the sales engineer and his supporting team try to make the sale, changing and improving the proposition as they get cues from the competitive situation. If the sale is made—a very satisfying moment—then the installation and service engineers install the equipment and are responsible for its operation and repair. With the exception of the product design engineers, all these people are in technical marketing. Exciting work, all of it.

Q. In college we learn engineering theory. How do we get the sales and business knowledge you mentioned?

A. At General Electric, a solid, well tested program of educational courses will quickly advance both your engineering knowledge and your sales capacities. But perhaps even more important, you'll be assigned to work with some of the crack sales engineers and application and installation men in the world, and that's no exaggeration. A man grows fast when he's on the sales firing line. As a FORTUNE writer once put it, the industrial sales engineer needs "that prime combination of technical savvy, tactical agility, and unruffled persuasiveness." Have you got what it takes?

699-08

Progress Is Our Most Important Product

GENERAL ELECTRIC